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Supplemental Information

Diverse Food-Sensing Neurons Trigger Idiothetic Local Search in *Drosophila*

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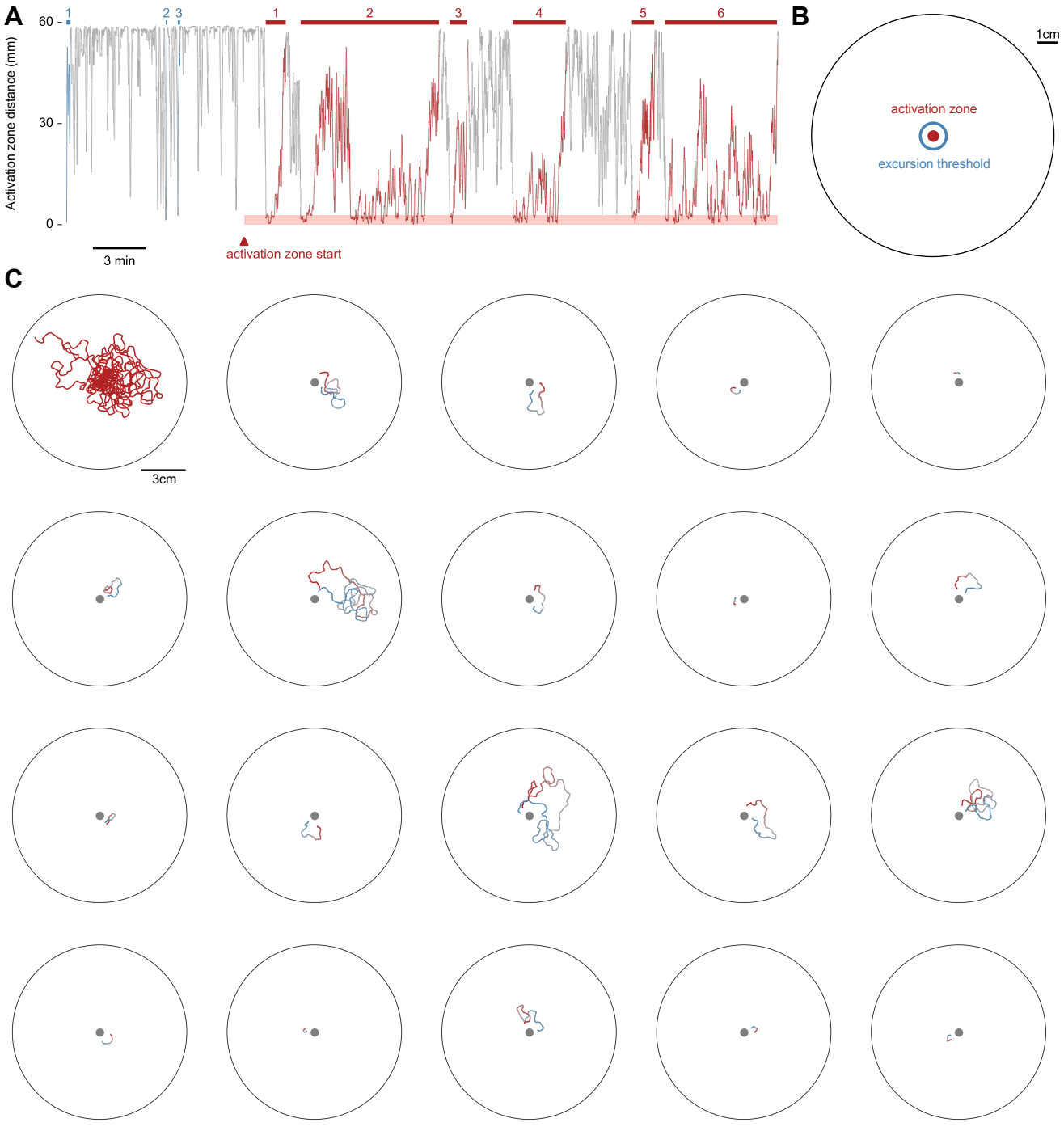

Figure S1. Local searches consist of excursions and revisits to the activation zone. Related to Figure 1.
(A) Example trial with a *Gr43a-GAL4>UAS-CsChrimson* animal, plotting distance between fly and activation zone center. Trials lasted 40 minutes, and the activation zone became operational after an initial 10-minute baseline control period. Red segments denote activation search bouts, defined as trajectories beginning with a light pulse and ending when the fly reaches the arena edge or at the conclusion of the trial. Blue segments denote the equivalent baseline control bouts with no light pulse.
(B) Schematic showing the 1.42 mm thick excursion threshold ring (blue) from the Schmitt-trigger analysis we used to divide search bouts into individual excursion events. An excursion begins when a fly that has received a light pulse crosses the excursion threshold ring in the outbound direction, and ends when the fly crosses the excursion threshold ring in the inbound direction. Each excursion is counted as a revisit to the activation zone.
(C) Full trajectory (top left) of search bout number 6 from (A) and trajectories of all individual excursions therein. Excursion trajectories are color-coded from start (red) to end (blue).

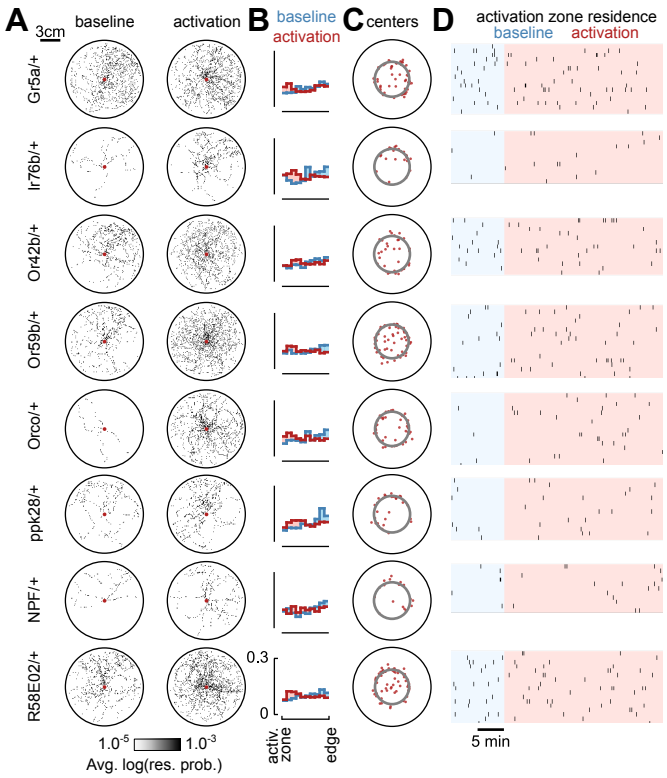

Figure S2. Additional parental controls for optogenetic screen. Related to Figure 1.
(A) Residence probabilities during activation search bouts and baseline control bouts, plotted as in Figure 1D.
(B) Probability distributions of distance between fly and activation zone, plotted as in Figure 1E.
(C) Centers of mass for all activation search bouts, plotted as in Figure 1F.
(D) Raster plots of activation zone residence, plotted as in Figure 1G.
(A-D) Sample sizes as in Figure 1.

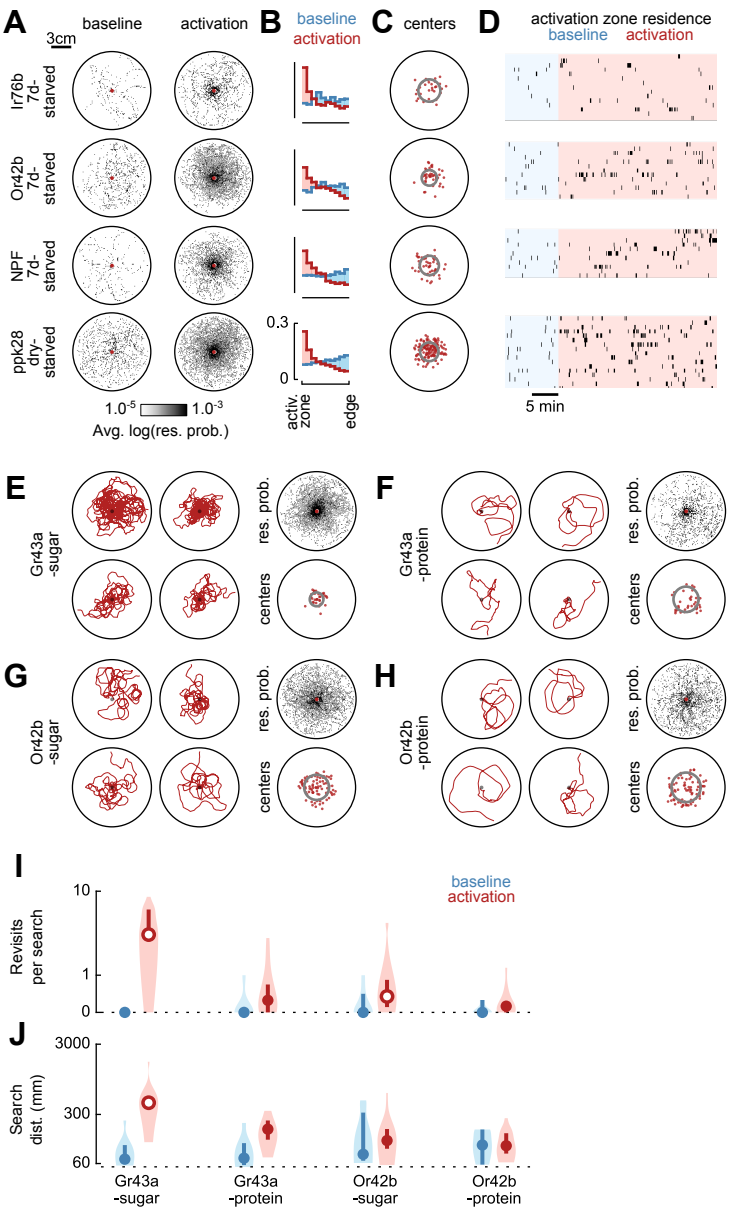

Figure S3. Local search is modulated by starvation state. Related to Figure 2.

(A) Residence probabilities during activation search bouts or baseline control bouts, plotted as in Figure 1D. Activation search bout residence probabilities reproduced from Figures 2G-J for convenience.

(B) Probability distributions of fly distance to the activation zone, plotted as in Figure 1E.

(C) Centers of mass for all activation search bouts, reproduced from Figures 2G-J for convenience.

(D) Raster plots of activation zone residence, plotted as in Figure 1G.

(A-D) Sample sizes as in Figure 2.

(E) Longest distance search bouts, residence probabilities, and centers of mass, for activation search bouts of sugar-deprived *Gr43a-GAL4>UAS-CsChrimson* animals, plotted as in Figure 2G.

(F) As in (E) for protein-deprived *Gr43a-GAL4>UAS-CsChrimson* animals.

(G) As in (E) for sugar-deprived *Or42b-GAL4>UAS-CsChrimson* animals.

(H) As in (E) for protein-deprived *Or42b -GAL4>UAS-CsChrimson* animals.

(I) Mean number of revisits to the activation zone for animals of the indicated genotype and starvation state, plotted as in Figure 1I.

(J) Mean distance walked during search bouts for animals of the indicated genotype and starvation state, plotted as in Figure 1J.

(E-J) Sample sizes: Gr43a -sugar, n=15; Gr43a -protein, n=14; Or42b -sugar, n=19; Or42b -protein, n=15.

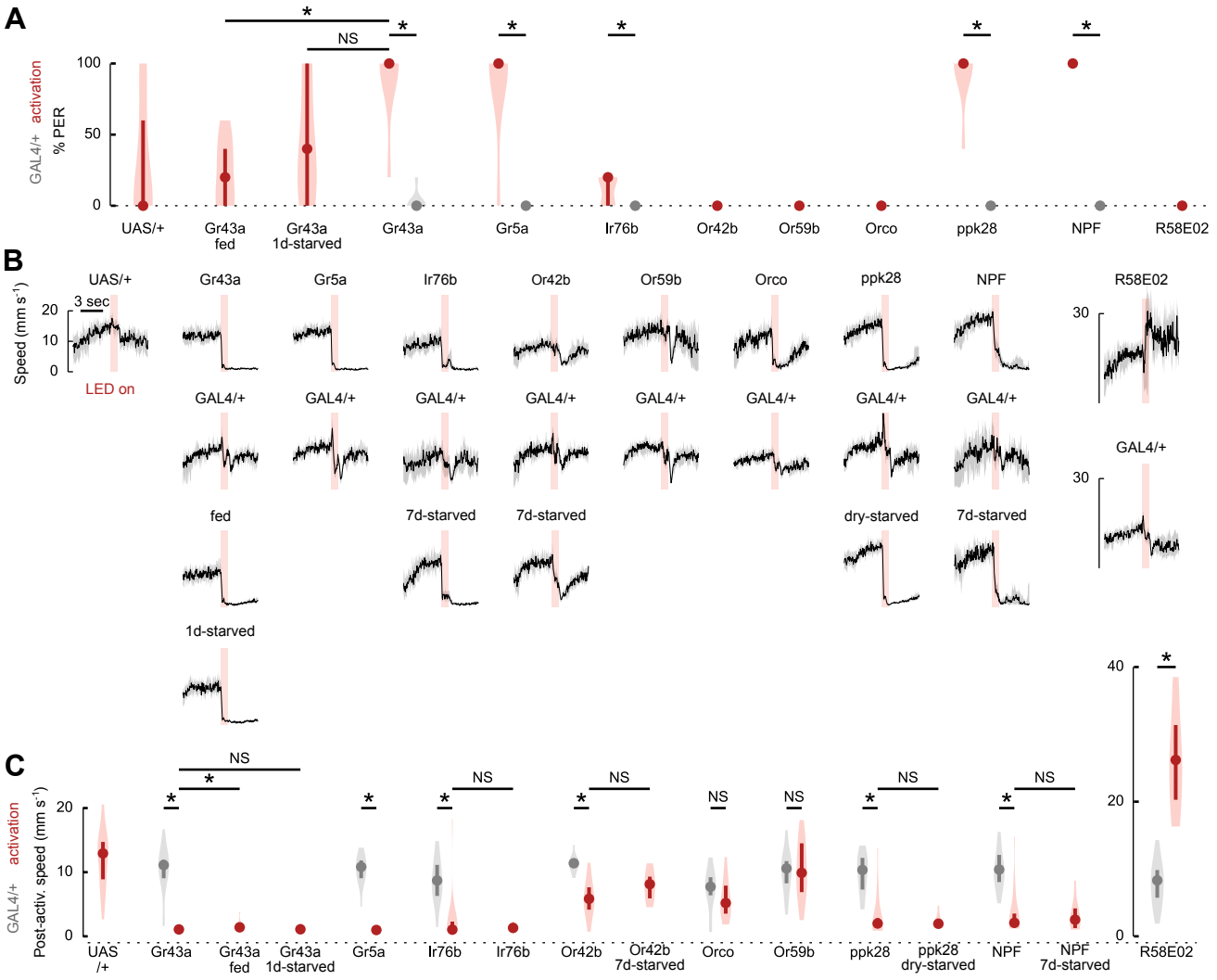

Figure S4. Proboscis extension and locomotor responses to activation. Related to Figure 2.

(A) Mean percentage of stimulus presentations eliciting a proboscis extension response (PER) for animals of the indicated genotype (red) or the corresponding GAL4-line parental controls (grey) and indicated starvation state. Data depict distribution of individual fly means. Circles depict medians, error bars depict 95% confidence intervals, and violin plots indicate full data distribution. We note that light pulses produce PER in some *UAS-CsChrimson/+* control animals, but we do not believe this hinders interpretation of the results because we find no PER response in multiple other lines expressing this transgene. (* indicates p≤0.05, NS indicates p>0.05, n=7 flies per condition, Mann-Whitney U test with Bonferroni correction).

(B) Median speed traces (solid black lines) during light pulse stimulation for animals of the indicated genotype and starvation state. Only the first light pulse for each search bout was used for analysis, and data were truncated if animals reached arena edge. Data depict distribution of individual fly median traces, with shaded grey region depicting 95% CIs. Data for *R58E02-GAL4>UAS-CsChrimson* animals are plotted on extended axes to accommodate values for higher speeds. To our knowledge, the increase in speed caused by activation of *R58E02-GAL4* has not previously been reported.

(C) Median post-activation speed (during the 4 seconds following light pulse offset) for animals of the indicated genotype (red) or corresponding GAL4-line parental controls (grey) and indicated starvation state. Plotting conventions as in (A). Only the first light pulse for each search bout was used for analysis, and data were truncated if animal reached arena edge. Data for *R58E02-GAL4>UAS-CsChrimson* animals are plotted on extended axes to accommodate values for higher speeds.